WHAT IS CLAIMED IS:

1. A tilt sensor for determining information related to a tilt of an object to a reference plane, comprising:

a diffraction element disposed at a position on an optical path of a light beam from the object, the position determined in accordance with a positional relation with the object, wherein the diffraction element diffracts diffraction light at a diffraction efficiency depending on an incident angle of the light beam; and

a photo detector that receives the diffraction light diffracted by said diffraction element and outputs an photoelectric signal.

2. The tilt sensor as claimed in claim 1, wherein an order of the diffraction light received by said photo detector is that of a diffracted light of

a greatest intensity.

3. The tilt sensor as claimed in claim 1, wherein said diffraction element is set so that the relation between the intensity of the diffraction light and the incident angle is substantially linear an a predetermined range of the incident angle.

4. The tilt sensor as claimed in claim 1, further comprising a differential signal generator,

wherein

said photo detector receives 0 order diffraction light from said diffraction element, and

said differential signal generator generates a differential signal between the photoelectric signal of the diffraction light and the 0 order diffraction light.

5. The tilt sensor as claimed in claim 1, further comprising a differential signal generator, wherein

said photo detector receives +1st order diffraction light and −1st order diffraction light from said diffraction element, and

said differential signal generator generates a differential signal between a photoelectric signal of the +1st order diffraction light and a photoelectric signal of the −1st order diffraction light.

6. The tilt sensor as claimed in claim 1, wherein

said diffraction element comprises a first region in which a grooved grating of a first groove direction is formed and a second region in which a grooved grating of a second groove direction is formed; and

said photo detector comprises a first photo

detecting unit that receives the diffraction light from the first region and a second photo detecting unit that receives the diffraction light from the second region.

7. The tilt sensor as claimed in claim 6, wherein an order of the diffraction light received by the first photo detecting unit and an order of the diffraction light received by the second photo detecting unit are those of diffracted light of the greatest intensity.

8. The tilt sensor as claimed in claim 6, wherein

said diffraction element is set so that

the relation between the intensity of the diffracted light received by the first photo detecting unit and the incident angle of the diffracted light beam to the first region is

substantially linear in a first range, and

the relation between the intensity of the diffracted light received by the second photo detecting unit and the incident angle of the diffracted light beam to the second region is substantially linear in a second range.

9. The tilt sensor as claimed in claim 6, further comprising a first differential signal generator,

wherein

said photo detector includes a third photo detecting unit that receives 0 order diffraction light from said diffraction element, and

said first differential signal generator generates a differential signal between a photoelectric signal from the first photo detecting unit and a photoelectric signal from the third photo detecting unit.

10. The tilt sensor as claimed in claim 9, further comprising a second differential signal generator,

wherein

said second differential signal generator generates a differential signal between a photoelectric signal from the second photo detecting unit and a photoelectric signal from the third photo detecting unit.

11. The tilt sensor as claimed in claim 6, further comprising a first differential signal generator,

wherein

the first photo detecting unit receives +1st order diffraction light and −1st order diffraction light from the first region, and

said first differential signal generator generates a differential signal between a photoelectric signal of the +1st order diffraction light and a photoelectric signal of the −1st order

diffraction light output by the first photo detecting unit.

12. The tilt sensor as claimed in claim 11, further comprising a second differential signal generator,

wherein

the second photo detecting unit receives +1st order diffraction light and −1st order diffraction light from the second region, and

said second differential signal generator generates a differential signal between a photoelectric signal of the +1st order diffraction light and a photoelectric signal of the −1st order diffraction light output by the second photo detecting unit.

13. The tilt sensor as claimed in claim 1, wherein a cross section of said diffraction element

is serriform.

14. The tilt sensor as claimed in claim 1, wherein the light beam from the object is a reflective light reflected by the object.

15. The tilt sensor as claimed in claim 14, further comprising a light source that emits a light beam to a direction forming an angle with the reference plane,

wherein

said diffraction element is disposed on an optical path of the reflective light reflected by the object.

16. The tilt sensor as claimed in claim 15,

further comprising an optical element disposed on an optical path of a light beam traveling from said light source to the object, wherein said optical element makes the light beam emitted by said light source substantially parallel.

17. The tilt sensor as claimed in claim 15, further comprising a phase difference plate,

wherein

said diffraction element is a polarization diffraction element that diffracts the light beam in a different manner depending on a polarization state of the light beam, and

said polarization difference plate rotates the directions of polarization in which the reflective light is polarized about by 90 degree to the directions of polarization in which the light beam emitted by said light source is polarized, the reflective light incoming to said polarization diffraction element.

18. A tilt measurement apparatus for determining a tilt angle of an object to a reference plane, comprising:

the tilt sensor as claimed in claim 15; and

a tilt angle determination unit that determines the tilt angle based on an output signal from said tilt sensor.

19. An optical pickup apparatus that applies a light to a recording surface of a recording medium and receives a reflective light from the recording surface, comprising:

the tilt sensor as claimed in claim 15, wherein the object is the recording medium;

a laser light source that emits a laser light, the wavelength of which corresponds to the recording medium;

an optical system including an object lens for converging the laser light on the recording surface, wherein said optical system guides the

reflective laser light reflected by the recording surface via the object lens to a receiving position; and

a photo detector disposed at the receiving position, wherein said photo detector receives the reflective light beam.

20. An optical pickup apparatus that applied a light to a recording surface of a recording medium and receives a reflective light from the recording surface, comprising:

a laser light source that emits a laser light, the wavelength of which corresponds to the recording medium;

an optical system including an object lens for converging the laser light on the recording surface, wherein said optical system guides the reflective laser light reflected by the recording surface via the object lens to a receiving position;

a signal light detector that receives disposed at the receiving position, wherein said signal light detector receives the reflective light

beam;

a split optical element disposed on an optical path of a light beam emitted by said laser light source to the object lens, wherein said split optical element splits a fraction of the laser light to the recording medium; and

the tilt sensor as claimed in claim 14, said diffraction element of which is disposed on an optical path of the laser light split by said split optical element and reflected by the recording medium, wherein the object is the recording medium.

21. An optical disk apparatus, comprising:

the optical pickup apparatus as claimed in claim 19;

an adjusting unit that adjusts a shape of light spot formed on the recording surface based on the output signal from said tilt sensor; and

a processing unit that at least reproduces information using the output signal from said optical pickup apparatus.

22. An optical disk apparatus, comprising:

the optical pickup apparatus as claimed in claim 20;

an adjusting unit that adjusts a shape of light spot formed on the recording surface based on the output signal from said tilt sensor; and

a processing unit that at least reproduces information using the output signal from said optical pickup apparatus.

23. A tilt sensor for detecting information related to a tilt of an object to a reference plane, comprising:

a diffraction unit disposed at a position on an optical path of a light beam via the object, the position determined in accordance with a positional relation with the reference plane, wherein said diffraction unit diffracts the light beam in first directions at a diffraction efficiency

determined by an incident angle of the light beam in the first directions, and diffracts the light beam in second directions at a diffraction efficiency determined by an incident angle of the light beam in the second directions; and

a photo detection unit that receives a diffraction light from said diffraction unit, and outputs a photo-electric signal.

24. The tilt sensor as claimed in claim 23, wherein said diffraction unit further comprises:

a first diffraction element that diffracts the light beam in the first directions at the diffraction efficiency determined by the incident angle of the light beam in the first directions; and

a second diffraction element that diffracts the light beam in the second directions at the diffraction efficiency determined by the incident angle of the light beam in the second directions.

25. The tilt sensor as claimed in claim 24, wherein said first diffraction element and said second diffraction element are laminated.

26. The tilt sensor as claimed in claim 24, wherein said first diffraction element satisfies

$2 \leq 2\pi\lambda T_a/n_a d_a^2 < 10$,

where λ denotes a wavelength of the light beam, n_a denotes a refraction index of said first diffraction element, T_a denotes depth of diffraction grating formed on said first diffraction element, and d_a denotes pitch of the diffraction grating formed on said first diffraction element.

27. The tilt sensor as claimed in claim 24, wherein said second diffraction element satisfies

$2 \leq 2\pi\lambda T_b/n_b d_b^2 < 10$,

where λ denotes a wavelength of the light

beam, n_b denotes a refraction index of said first diffraction element, T_b denotes depth of diffraction grating formed on said second diffraction element, and d_b denotes pitch of the diffraction grating formed on said second diffraction element.

28. The tilt sensor as claimed in claim 23, wherein a first diffraction grating and a second diffraction grating are formed on a same surface of said diffraction unit, wherein the first diffraction grating diffracts the light beam in the first directions at the diffraction efficiency determined by the incident angle of the light beam in the first directions, and the second diffraction grating diffracts the light beam in the second directions at the diffraction efficiency determined by the incident angle of the light beam in the second directions.

29. The tilt sensor as claimed in claim 28,

wherein the first diffraction grating satisfies

$$2 \leq 2\pi\lambda T_a/n_a d_a^2 < 10,$$

where λ denotes a wavelength of the light beam, n_a denotes a refraction index of the first diffraction grating, T_a denotes depth of the first diffraction grating, and d_a denotes pitch of the first diffraction grating.

30. The tilt sensor as claimed in claim 28, wherein the second diffraction grating satisfies

$$2 \leq 2\pi\lambda T_b/n_b d_b^2 < 10,$$

where λ denotes a wavelength of the light beam, n_b denotes a refraction index of the second diffraction grating, T_b denotes depth of the second diffraction grating, and d_b denotes pitch of the second diffraction grating.

31. The tilt sensor as claimed in claim 23, wherein the first directions and the second

directions are substantially perpendicular to each other.

32. The tilt sensor as claimed in claim 23, further comprising:

a polarization unit disposed on the optical path between said diffraction unit and said photo detection unit, wherein said polarization unit polarizes the diffraction light from said diffraction unit,

wherein

said photo detection unit receives a diffraction light polarized by said polarization unit.

33. The tilt sensor as claimed in claim 23, further comprising:

a convergence lens disposed on the optical path between said diffraction unit and said photo detection unit, wherein said convergence lens

converges the diffraction light from said diffraction unit,

wherein

said photo detection unit receives a diffraction light converged by said convergence lens.

34. The tilt sensor as claimed in claim 23, further comprising:

a light source that emits the light beam; and

an optical unit disposed on the optical path between said light source and the object, wherein said optical unit makes the light beam emitted by said light source substantially parallel.

35. The tilt sensor as claimed in claim 34, wherein

said optical unit and said diffraction unit are combined as a single unit.

36. The tilt sensor as claimed in claim 34, wherein

said light source and said photo detector are built in a package.

37. The tilt sensor as claimed in claim 36, wherein

the light beam emitted by said light source and the light beam via the object are polarized in different directions, and

said diffraction unit diffracts the light beam via the object at a higher diffraction efficiency than a diffraction efficiency at which said diffraction unit diffracts the light beam emitted by said light source.

38. A tilt sensor for detecting information related to a tilt of a first object to a reference plane, and information related to a tilt of a second object to the reference plane, comprising:

a first diffraction unit disposed at a position on an optical path of a first light beam via the first object, the position determined in accordance with a positional relation with the reference plane, wherein said first diffraction unit diffracts the first light beam in first directions at a diffraction efficiency determined by an incident angle of the first light beam in the first directions, and diffracts the first light beam in second directions at a diffraction efficiency determined by an incident angle of the first light beam in the second directions;

a second diffraction unit disposed at a position on an optical path of the second light beam via the second object, the position determined in accordance with a positional relation with the reference plane, wherein said second diffraction unit diffracts the second light beam in first directions at a diffraction efficiency determined by an incident angle of the second light beam in the first

directions, and diffracts the second light beam in second directions at a diffraction efficiency determined by an incident angle of the second light beam in the second directions; and

a photo detection unit that receives a diffraction light from said first diffraction unit and a diffraction light from said second diffraction unit, and outputs a photo-electric signal.

39. The tilt sensor as claimed in claim 38, wherein

said first diffraction unit further comprises:

a first light beam first diffraction element that diffracts the first light beam in the first directions at the diffraction efficiency determined by the incident angle of the first light beam in the first directions; and

a first light beam second diffraction element that diffracts the first light beam in the second directions at the diffraction efficiency determined by the incident angle of the first light

beam in the second directions.

40. The tilt sensor as claimed in claim 39, wherein

said first light beam first diffraction unit and said first light beam second diffraction unit are laminated.

41. The tilt sensor as claimed in claim 38, wherein

a first light beam first diffraction grating and a first light beam second diffraction grating are formed on a same surface of said diffraction unit, wherein the first light beam first diffraction grating diffracts the first light beam in the first directions at the diffraction efficiency determined by the incident angle of the first light beam in the first directions, and the first light beam second diffraction grating diffracts the first

light beam in the second directions at the diffraction efficiency determined by the incident angle of the first light beam in the second directions.

42. The tilt sensor as claimed in claim 38, wherein

said second diffraction unit further comprises:

a second light beam first diffraction element that diffracts the second light beam in the first directions at the diffraction efficiency determined by the incident angle of the second light beam in the first directions; and

a second light beam second diffraction element that diffracts the second light beam in the second directions at the diffraction efficiency determined by the incident angle of the second light beam in the second directions.

43. The tilt sensor as claimed in claim 42, wherein

said second light beam first diffraction element and said second light beam second diffraction element are laminated.

44. The tilt sensor as claimed in claim 38, wherein

a second light beam first diffraction grating and a second light beam second diffraction grating are formed on a same surface of said second diffraction unit, wherein the second light beam first diffraction grating diffracts the second light beam in the first directions at the diffraction efficiency determined by the incident angle of the second light beam in the first directions, and the second light beam second diffraction grating diffracts the second light beam in the second directions at the diffraction efficiency determined by the incident angle of the second light beam in the second directions.

45. The tilt sensor as claimed in claim 38, wherein

the first light beam and the second light beam are polarized in different directions;

said first diffraction unit diffracts the first light beam at a higher diffraction efficiency than a diffraction efficiency at which said first diffraction unit diffracts the second light beam; and

said second diffraction unit diffracts the second light beam at a higher diffraction efficiency than a diffraction efficiency at which said second diffraction unit diffracts the first light beam.

46. The tilt sensor as claimed in claim 38, wherein

the first directions and the second directions are substantially perpendicular to each other.

47. The tilt sensor as claimed in claim 38, further comprising:

a polarization unit that polarizes the diffraction light,

wherein

said photo detection unit receives a diffraction light polarized by said polarization unit.

48. The tilt sensor as claimed in claim 38, further comprising:

a convergence lens that converges the diffraction light,

wherein

said photo detection unit receives a diffraction light converged by said convergence lens.

49. An optical pickup apparatus, comprising:

a signal light source that emits a signal light beam, a wavelength of which corresponds to an optical disk;

an optical system that guides the signal light beam to the optical disk;

a photo detector that detects a reflective light beam reflected by the optical disk, wherein the reflective light beam is guided by said optical system;

a sensor light source that emits a sensor light beam to the optical disk; and

the tilt sensor as claimed in claim 23, wherein the tilt sensor is disposed on an optical path of the sensor light beam reflected by the optical disk, and the optical disk is the object.

50. An optical pickup apparatus, comprising:

a signal light source that emits a signal

light beam, a wavelength of which corresponds to an optical disk;

an optical system that guides the signal light beam to the optical disk;

a photo detector that detects a reflective light beam reflected by the optical disk, wherein the reflective light beam is guided by said optical system; and

the tilt sensor as claimed in claim 34, wherein the tilt sensor is disposed on an optical path of the sensor light beam reflected by the optical disk, and the optical disk is the object.

51. An optical pickup apparatus, comprising:

a signal light source that emits a signal light beam, a wavelength of which corresponds to an optical disk;

an optical system that guides the signal light beam to the optical disk, said optical system including an object lens that converges the signal light beam on a recording surface of the optical

disk;

a photo detector that detects a reflective light beam reflected by the optical disk, wherein the reflective light beam is guided by said optical system;

a sensor light source that emits a sensor light beam to the optical disk;

a splitter unit disposed on an optical path of the sensor light beam, wherein said splitter unit splits the sensor light beam; and

the tilt sensor as claimed in claim 38, wherein the first light beam is the sensor light beam reflected by said splitting unit, and the second light beam is the sensor light beam that transmits through said splitting unit and is reflected by the optical disk.

52. An optical disk apparatus that can at least reproduce data written on a recording surface of an optical disk, comprising:

the optical pickup apparatus as claimed in claim 49;

an adjusting unit that adjusts wave front aberration of a light spot formed on the recording surface of the optical disk based on an output signal from the tilt sensor of the optical pickup apparatus; and

a processing unit that at least reproduces data using an output signal from said photo detector.

53. A tilt sensor for detecting information related to a tilt of an object to a reference plane, comprising:

a diffraction element having a diffraction grating disposed at a position on an optical path of a light beam from the object, the position determined in accordance with a positional relation with the object, wherein the diffraction grating diffracts the light beam at a diffraction efficiency depending on an incident angle of the light beam;

a photo detector that receives a $\pm 1^{st}$ order diffraction lights diffracted by said diffraction element and outputs an photoelectric signal; and

a differential signal generation unit that

generates a differential signal between the +1st order diffraction signal and −1st order diffraction signal,

wherein the tilt sensor is set to detect incident angle within a detectible range between $\pm\theta$, θ being Bragg's angle,

$$\sin\theta = \frac{\lambda}{2\Lambda}$$

where λ denotes a wavelength of the light beam, and Λ denotes a pitch of the diffraction grating.

54. The tilt sensor as claimed in claim 53, wherein

the diffraction grating satisfies:

$$\frac{n\Lambda^2}{\pi\lambda} \leq d \leq 4.5\times\frac{n\Lambda^2}{\pi\lambda}$$

where d denotes depth of the diffraction grating, n denotes an average of a refraction index n0 of material forming the diffraction grating and n1 of material filling a ditch of the diffraction grating.

55. The tilt sensor as claimed in claim 53, wherein

the diffraction grating satisfies:

$$\frac{\lambda}{4d} \leq \Delta n \leq \frac{\lambda}{d}$$

where Δn denotes a difference between a refraction index n0 of material forming the diffraction grating and n1 of material filling a ditch of the diffraction grating.

56. The tilt sensor as claimed in claim 53, wherein

said diffraction element has a first diffraction grating of first grating directions and a second diffraction grating of second grating directions different from the first grating directions.

57. The tilt sensor as claimed in claim 56, wherein

the first diffraction grating and the second diffraction grating are substantially perpendicular to each other.

58. The tilt sensor as claimed in claim 56, wherein

the first diffraction grating and the second diffraction grating are formed on a single substrate.

59. The tilt sensor as claimed in claim 58, wherein the first diffraction grating and the second diffraction grating are formed on the same surface of the substrate.

60. The tilt sensor as claimed in claim 53, further comprising:

a 1/4 wavelength plate disposed between said diffraction element and the object,

wherein

said diffraction element is polarizable, the diffraction efficiency of which depends on a polarization of the incident light beam.

61. A tilt sensing apparatus, comprising:

the tilt sensor as claimed in claim 53; and

a tilt angle measuring unit that measures the tilt angle of the object to the reference plane based on an output signal from the tilt sensor.

62. An optical pickup apparatus that at

lease reproduce information in a recording medium, comprising:

the tilt sensor as claimed in claim 53;

a light source that emits a light beam of a wavelength corresponding to the recording medium;

an object lens that converges the light beam on a recording surface of the recording medium;

an optical system that guides the light beam to the recording surface and guides a reflective light beam reflected by the recording surface to a receiving position; and

a photo detector disposed at the receiving position that receives the reflective light beam.

63. An optical disk driving apparatus, comprising:

the optical pickup apparatus as claimed in claim 62;

an adjusting unit that adjusts a shape of a light spot formed on the recording surface of the recording medium based on an output signal from the tilt sensor;

an information processing unit that at least reproduces information by applying the light beam to the recording surface of the recording medium.